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What is the cause of beam hardening artifact on CT?

High density tissue, objects, and structures attenuate lower-energy photons preferentially, thereby selecting higher-energy photons for image reconstruction as the higher energy photons are able to pass through the denser tissues and reach the imaging detector, thereby "hardening" the CT beam. Because image reconstruction assumes that all beams or projections have the same beam hardness, you end up with artifacts when the beam hardness differs from what the image reconstruction algorithm—typically filtered back projection—assumes. The result is both bright and dark streaks around really high density objects on CT images.

How can beam hardening artifact be reduced?

Several methods exist to reduce beam hardening artifact such as selecting higher kVp settings to allow more energetic beams to travel through and not be absorbed as much by high density objects or using metal artifact reconstruction algorithms/beam-hardening corrections.

What causes a ring artifact on CT?

For board exams, first consider a detector problem with poor calibration as a cause of ring artifact. Other causes can be contrast material or other debris on the detector covering, or imaging with insufficient dose. To troubleshoot, clean detector and call your medical physicist to troubleshoot and potentially recalibrate the system.

What is the underlying cause of volume averaging artifact on CT?

When a voxel is large enough to contain tissues of different attenuation values, the average attenuation of the tissues in that voxel is what will be depicted on the image. This can create situations where anatomic areas appear slightly higher or lower in density than truth due to the averaging effect of immediately adjacent tissues at tissue density interfaces. This can be especially pronounced in places such as the lungs where you can have high density material in arteries immediately adjacent to low density, air filled lung. To reduce this artifact, using thinner image slices and using narrower detector channels can be helpful.

What is truncation artifact on CT and how do you reduce this?

Truncation artifact results when the portion of the body being imaged exceeds the field of view of CT. The artifact often shows curvilinear bright bands that occur on the edges of the image where the body extends beyond the field of view. To reduce this artifact, widen the field of view, if possible, and try to position the patient within the center of the gentry, or shift anatomy around, such as arms raised or lowered, to help include the entire anatomy within the field of view.

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What is zipper artifact on MRI and how do you reduce this?

Zipper artifact results from radiofrequency interference, typically from an extrinsic radiofrequency signal that occurs classically in the phase encoding direction. This appears as alternating light and dark bands similar to a zipper across the image. There are a few classic, commonly tested causes for zipper artifact on board exams. First, the door to the MRI scanner room not being closed tight, or having a damaged/faulty seal, some sort of breach of the Faraday cage around the MRI scanner room, or some sort of electronic device located within the room that is giving off RF signals. This is a particularly high-yield entity for radiology board exams.

What is Gibbs artifact on MRI?

This is a highly tested MRI artifact because it can appear similar to a spinal cord syrinx due to an artifactual linear hyperintense signal that can be seen near the spinal-cord CSF interface. These interfaces cause alternating high and low bands of signal at high-contrast tissue interfaces due to limiting sampling using Fourier transform analysis. This is more common in the Phase encode direction, as this is often the step that is more undersampled in order to scan faster.

What is pulsation artifact on MRI and how do you reduce this?

Pulsation artifact occurs when pulsation of a vessel causes misplacement of some of the signal from the pulsating vessel elsewhere on the MRI image, importantly in the phase-encode direction. For example, with pulsation artifact form the aorta, a similar sized round structure to the aorta on that slice may project elsewhere than the actual aorta directionally along the phase-encode direction. To reduce this artifact, use faster MRI pulse-sequences, increase sampling, use pre-saturation bands, and/or consider switching the phase-encode direction.

What is susceptibility artifact on MRI and how do you reduce this?

Susceptibility artifact is a black or extremely low signal abnormality on MRI that surrounds a material that causes local field inhomogeneities, such as blood, metal, etc. Another name for this artifact is blooming artifact. When these materials cause local field inhomogeneities, you lose MRI signal due to accelerated dephasing of spins. To reduce susceptibility artifact, some sequences, such as spin-echo sequences, are superior. In general, sequences that reduce the echo time will have less susceptibility artifact.

What is aliasing artifact on MRI and how do you reduce this?

Aliasing artifact is also known as “wrap around” artifact and occurs when anatomy not included in the sampling field of view ends up on the opposite side of the image. It is key to know what this looks like so look it up, if you don’t already know. This is also highly tested. The cause is when the field of view of MRI is smaller than the anatomy being imaged and this occurs in the phase-encoding direction. To reduce increase the field of view and/or sampling bandwidth.

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True or false: Magnetic field inhomogeneities in the main magnetic field can cause Moire' fringes.

True. This artifact caused by interference patterns that both add and cancel signal and looks really cool in my opinion. Look it up so you know what this looks like on a board exam question. One cause of this is a main magnetic field that has poor shimming and resulting magnetic field inhomogeneity. To fix? Use improved shimming to get a more homogeneous magnetic field.

What is chemical shift artifact of the first kind?

This causes dark and bright borders around anatomic structures at interfaces of fat and soft tissue, classically tested on the kidneys. For example, you would see a bright border around the leftward aspect of both kidneys and a dark border around the rightward aspect of both kidneys. The cause is spatial misregistration that results from differences in the frequencies of precession at interfaces of fat and soft tissue. This occurs in the frequency-encoding direction. This is minimized on MRI with fat-saturation.

What is chemical shift artifact of the second kind?

You know if there are two of anything, the odds that you will be tested on the difference between these increases on board exams and this is no exception. Chemical shift artifact of the 2nd kind causes the classic India Ink artifact which is a characteristic dark border at interfaces of fat and soft tissue on MRI. This is most classically seen and tested on out-of-phase MRI. This results because the signals from fat and water at the interface partially cancel causing focal signal loss.

How is MRI dielectric artifact commonly tested?

On board exams, look for the anatomically large abdomen with ascites that shows MRI with vague darkening in the center of the image on a 3T scanner. Basically, the radiofrequency wavelength at 3T is about the same as the diameter of a large patient and if ascites is present this can cause signal interference and loss of signal centrally and peripheral brightening. Look up images so you know what this classically looks like. This is less common on 1.5T so if you see this, image the patient on a 1.5T scanner to get better images.

How is MRI magic angle artifact commonly tested?

Magic angle artifact is classically tested on shoulder MRIs by showing what appears to be a tendon tear or tendinopathy of the supraspinatus tendon due to artifact that causes higher signal in the tendon within tendinous molecules at precisely 54.74 degrees from the magnetic field (B0). To evaluate for this, you should confirm for a real tendon abnormality versus magic angle artifact by seeing if there is evidence of signal abnormality on other MRI sequences, or if it is only seen on sequences with short echo times such as T1, PD, GRE and not on T2 sequences. Other anatomic sites prone to this artifact include the proximal posterior cruciate ligament, the peroneal tendons and the triangular fibrocartilage complex.